Western Michigan University
ScholarWorks at WMU

Transactions of the International Conference on
Health Information Technology Advancement

Center for Health Information Technology
Advancement

10-2015

Realizing the Value of EHR Systems: Critical Success Factors

Elizabeth A. Regan

University of South Carolina, earegan@mailbox.sc.edu

Jumee Wang

University of South Carolina, wang389@email.sc.edu

Follow this and additional works at: https://scholarworks.wmich.edu/ichita_transactions

Part of the Health Information Technology Commons

WMU ScholarWorks Citation

Regan, Elizabeth A. and Wang, Jumee, "Realizing the Value of EHR Systems: Critical Success Factors" (2015). *Transactions of the International Conference on Health Information Technology Advancement*. 57.

https://scholarworks.wmich.edu/ichita_transactions/57

This Article is brought to you for free and open access by the Center for Health Information Technology Advancement at ScholarWorks at WMU. It has been accepted for inclusion in Transactions of the International Conference on Health Information Technology Advancement by an authorized administrator of ScholarWorks at WMU. For more information, please contact wmu-scholarworks@wmich.edu.

Realizing the Value of EHR Systems: Critical Success Factors

Elizabeth A. Regan, Ph.D.
University of South Carolina
Department of Integrated Information Technology
earegan@mailbox.sc.edu
803-777-2286

Jumee Wang, MPH, PhD candidate
University of South Carolina
Arnold School of Public Health
wang389@email.sc.edu
803-777-1627

Abstract: Now that a majority of hospitals and primary care physicians have made the transition to electronic health record (EHR) systems, realizing value from this investment has become a major issue. The issue raises two key questions: Why do so many EHR implementations continue to fall short of achieving intended healthcare outcome goals? What differentiates those that succeed from those that fall short? This article builds on prior research using a systems framework to analyze the EHR implementation process. It focuses on ten common themes (CSFs) that appear to differentiate institutions which achieve positive healthcare outcomes from those that do not. Results are highly relevant for healthcare institutions now seeking to focus on realizing the value of their EHR systems.

INTRODUCTION

Now that a majority of hospitals and primary care physicians have made the transition to electronic health record (EHR) systems, realizing the full value from this investment has become a major issue. A recent College of Healthcare Information Management Executives (CHIME) survey indicates that optimization of EHRs will be a top priority in the next year for over 70 percent of respondents (Leventhal, 2015). This is hardly surprising since health IT implementation projects frequently fall short of achieving their potential. In fact this result is true of IT implementations across all industries; research indicates that half or more of IT projects continue to fall short of target goals (Aguirre, 2014). The key question for EHR implementation is what differentiates initiatives that succeed from those that fall short? This article builds on the authors' earlier research examining organizational EHR implementation from a systems framework to identify factors that differentiate institutions that achieve positive outcomes from those that report little to no impact and sometimes negative results. The primary aim is to identify what healthcare organizations that achieve the best results share in common that may account for their success in 'meaningfully using' health IT to improve care delivery.

A publicly subsidized demonstration project that implemented comprehensive, point-of-care, clinician-centric health IT systems in 20 New York city-area nursing homes illustrates the problem. The research findings reported considerable variation in outcomes:

"Despite the fact that each home implemented the same software and hardware via the same vendor, there have been variations observed both by early research findings and by the 1199 Training Fund coordinators about how the adoption of HIT has affected, and has been used by, homes. Examples of these differences range from how homes responded to bugs in the HIT system, to whether the technology was fundamentally perceived as a means of improving clinical indicators, financial outcomes, employee efficiency, or the entire culture of a home and perceived time savings. Variation was also reported in use of available health IT data. The quality improvement possibilities inherent in these capabilities are very rich, but not all homes have engaged in these types of analyses and customizations, and those that did, pursued different strategies."(Klinger & White, 2010)

Although there is a growing consensus that health information technology and exchange play foundational roles in addressing cost, quality, and access challenges of the United States healthcare system, prescriptions for how to get there successfully vary widely. Frequent failure to achieve intended healthcare outcomes is evident in the growing attention being placed on EHR "optimization" and "realizing the value of health IT." Despite well-established methodologies and recommendations for managing health IT implementation initiatives, the same lessons continue being learned through trial and error by clinicians, health IT specialists, and healthcare systems of every ilk. The

cost is significant in dollars and results, with some experts reporting failure to achieve intended results 50 percent or more of the time (Keshavjee, 2006; Leviss, 2010; Goroll, Simon, Tripathi, Ascenzo, & Bates, 2009). Studies assessing the impact of EHRs tend to focus on technical factors, overlooking the possibility, as systems theory would suggest, that lack of results may be attributable to people, process, and other dynamics of the healthcare setting rather than the technology itself.

Systems theory provides a framework for viewing health IT implementation holistically as opposed to reductionistically. It recognizes the extremely complex dynamics of the healthcare environment. The objective is not just to look at individual factors, but to also look at the complex interaction of people, process, and technology to gain better insight into differences in outcomes.

Our initial study findings (Regan & Wang, 2015) identified ten context, process, and technology variables that appear to differentiate institutions which have been most successful in achieving *meaningful use* (i.e., optimizing or achieving the value of EHRs). In order to further validate and clarify previous findings, this second phase of the study compared additional examples of EHR implementation and related research on the systemic nature of innovation and change. Results are highly relevant for healthcare institutions now seeking to focus on realizing the value of their EHR systems. The intent is to move beyond basic questions of whether health IT creates value to focus more on understanding *how* the technology can be “meaningfully” used to transform care delivery to achieve the primary aim of increasing patient access and improving quality of patient care at reduced costs (Jones, 2014, p.52).

BACKGROUND / LITERATURE REVIEW

As the momentum for transitioning to electronic health records accelerates, the national focus has shifted from buying and using the technology to sharing information across the continuum of care and transforming the United States health care system. Many observers believe that national momentum for healthcare change has reached the “tipping point,” in the terminology of Malcolm Gladwell. However, the challenges of realizing value from investments in transitioning to EHR systems on a national basis remain daunting. Buy-in among healthcare professionals continues to be problematic (Khoja, 2013; Coplan, 2013; Heisey-Grove, 2014).

To further validate and clarify previous findings, the second phase of research has focused on identifying additional multifunctional health IT interventions published since 2012. Research reports and case studies, both success stories and failures, evaluated in the first phase of this project, identified a wide range of variables believed to impact outcomes. These variables, which relate to people and process as well as technology, are presented in the form of incentives, barriers, lessons learned, implementation guidelines, and others. Lau et al. (2012) identified over 100 factors in their review of 43 selected studies. Table 1 and 2 provide two representative frameworks showing the many variables associated with successful implementations of EHR systems. Table 1 is based Karim Keshavjee et al.’s (2006) systematic review of EHR implementation frameworks. They concluded that existing EHR implementation frameworks did not explain all elements experienced by implementers and have not helped to make EHR implementation any more successful. Table 1 summarizes their overarching framework that integrates multiple conceptual frameworks with the goal of explaining factors that lead to successful EHR implementation. Table 2 is based on the work of Dr. Kenneth G. Adler, MD (2007). He organizes the key factors of EHR implementation into three categories: team, tactics, and technology. His summary is intended as a practice guideline for practitioners of a successful EHR implementation. To a large extent it parallels the framework offered by Keshavjee et al., (2006) yet it also includes some different emphases. Although informative, these studies do not address the issue of why so many EHR implementations fail to achieve anticipated benefits.

Table 1. Recommendations for Planning and Implementing EMR Systems

Critical Questions	People, Process, or Technology (description)
PRE-IMPLEMENTATION PHASE	
<ul style="list-style-type: none"> • Whose vision is it? • Why are we doing it? • What is the mission of project? 	<ul style="list-style-type: none"> • Governance (people) - A senior management's activities or substantive personal intervention in the management
<ul style="list-style-type: none"> • Who is in charge? 	<ul style="list-style-type: none"> • Project management leadership (people) – Bridge between top management and other stakeholders <ul style="list-style-type: none"> ○ Project Manager - Plan, motivate, evaluate EMR, etc. ○ Project Champion – Gain enthusiasm within work group <ul style="list-style-type: none"> ▪ Within large organization – Use EMR Committee
<ul style="list-style-type: none"> • How does it help the organization or employees? • Does it make “my job” easier? 	<ul style="list-style-type: none"> • Analyze state of ‘organization’s readiness’ (process) <ul style="list-style-type: none"> ○ Prepare for the change ○ Demonstrate benefits to all addressing barriers or obstacles
<ul style="list-style-type: none"> • What do all stakeholders think? 	<ul style="list-style-type: none"> • Involve multiple stakeholders (people) - Gain active participation and effective support
<ul style="list-style-type: none"> • What applications, features, etc., are needed? 	<ul style="list-style-type: none"> • Carefully select software, hardware, databases (process) <ul style="list-style-type: none"> ○ Conduct thorough needs analysis ○ Systematically evaluate technology alternatives
<ul style="list-style-type: none"> • Can all data be accessed where ever or whenever needed? 	<ul style="list-style-type: none"> • System interoperability (technology) <ul style="list-style-type: none"> ○ Integrate with existing information systems ○ Develop strategy to pre-load all existing data
<ul style="list-style-type: none"> • How is each feature used? 	<ul style="list-style-type: none"> • Technology usability (technology) <ul style="list-style-type: none"> ○ Hardware – placement, type, and ease-of-use of devices ○ Software –user interfaces and support of clinical workflows and processes
IMPLEMENTATION PHASE	
<ul style="list-style-type: none"> • How will my job change? 	<ul style="list-style-type: none"> • Workflow and redesign (process) <ul style="list-style-type: none"> ○ Understand the patient care process ○ Fit staff and physicians clinical workflows together
<ul style="list-style-type: none"> • How do I do this? 	<ul style="list-style-type: none"> • Training (people) <ul style="list-style-type: none"> ○ Initial provided by vendor in language of users ○ On-going required to gain expertise
<ul style="list-style-type: none"> • What problems do we have? 	<ul style="list-style-type: none"> • Strong vendor partnership (people) <ul style="list-style-type: none"> ○ Responsive to identified system modifications or improvements during the implementation ○ Efficient and effective on-site help desk ○ Select and develop ‘super-users’ within the organization
<ul style="list-style-type: none"> • Who’s going to help when you leave? 	<ul style="list-style-type: none"> • Support (process) <ul style="list-style-type: none"> ○ Develop strategy for ongoing support
<ul style="list-style-type: none"> • Who do I talk to about a problem? 	<ul style="list-style-type: none"> • Feedback and dialogue (people) <ul style="list-style-type: none"> ○ Regular staff / review meetings ○ Trouble-tracking systems with reports ○ Continuous implementation evaluation, monitoring, and tracking
<ul style="list-style-type: none"> • Whose record is it? 	<ul style="list-style-type: none"> • Privacy and confidentiality (process) <ul style="list-style-type: none"> ○ Must meet continually changing legal requirements ○ Requires trade-offs between confidentiality and access
POST-IMPLEMENTATION PHASE	
<ul style="list-style-type: none"> • What happens in an emergency? 	<ul style="list-style-type: none"> • Technical support and business continuity (technology) <ul style="list-style-type: none"> ○ Vendor contract agreements specify levels of support ○ Business continuity plan identifies roles, responsibilities, processes
<ul style="list-style-type: none"> • Where do we find continuing help? 	<ul style="list-style-type: none"> • User groups (people) <ul style="list-style-type: none"> ○ Scheduled user meetings led by EMR champions increases user acceptance ○ On-going system refinements increase user satisfaction
<ul style="list-style-type: none"> • Why should I bother? 	<ul style="list-style-type: none"> • Incentives (process) <ul style="list-style-type: none"> ○ Reinforce benefits to users and improved patient care ○ Demonstrate cost and time efficiencies

(Regan & Wang, 2015)

Table 2. The Three T's of a Successful EHR Implementation

TEAM	TACTICS	TECHNOLOGY
Senior support and project champion <ul style="list-style-type: none"> Identify one or more EHR champions or don't implement Make sure your organization's senior executive fully supports the EHR Project manager and management <ul style="list-style-type: none"> Use an experienced, skilled project manager Utilize sound change management principles Goals and expectations <ul style="list-style-type: none"> Have clear, measurable goals Make sure users share your goals Establish realistic expectations Don't try to implement an EHR in a dysfunctional organization 	Process - planning <ul style="list-style-type: none"> Plan, plan, plan Redesign your workflow Don't automate processes just because you can; make sure the automation improves something Design a balanced scanning strategy Process - implementation <ul style="list-style-type: none"> Pick a vendor with an excellent reputation for support Utilize a phased implementation Consistently enter key data into your new EHR charts Get data into the EHR electronically when possible Don't "go live" on a Monday Lighten your workload when you "go live" and for a short period afterward People <ul style="list-style-type: none"> Train, train, train Be flexible in your documentation strategy and allow individual differences in style Don't underestimate how much time and work is involved in becoming "expert" with an EHR Utilize "power users" at each site 	Hardware <ul style="list-style-type: none"> If you're a small practice, consider an Application Service Provider (ASP) model. Don't scrimp on your IT infrastructure. Make sure your servers and interfaces are maintained on a daily basis. People <ul style="list-style-type: none"> Make sure that your IT personnel do adequate testing. Utilize expert IT advice when it comes to servers and networks. Process <ul style="list-style-type: none"> Back up your database at least daily. Have a disaster recovery plan and test it.

(Regan & Wang, 2015) Taken from Adler (2007). "How to Successfully Navigate Your EHR Implementation."

Some of the myriad of variables might be considered in the category of sound planning and project management. Some may be particular to a given project; others are common across all projects. All the variables potentially influence the outcomes of any given project. However, missteps in addressing many of these factors often are correctable. The missteps may result in slowing down progress or require going back and modifying initial plans. However, they do not necessarily doom a project. Yet we also know that over half of health IT projects do fail, either falling short of intended improvements, leading to disuse, or resulting in cancellation. The question raised by our current study is whether, among all the many variables that must be addressed, it is possible to identify some that are critical to success; that is, they consistently make or break projects across many settings and projects. A related question is whether the critical success factors might change over time as implementation of health technology progresses along the adoption curve. In other words, are the factors the same among innovators and early adopters as they are among the early majority, and will be among the late majority and laggards? For example, might the critical factors change as healthcare innovation passes the "tipping point," as the momentum and evidence build? Another interesting aspect of this question is to what extent it is realistic to expect institutions to learn from the experience of others and to what extent each institution needs to go through the tough learning curve on its own.

This second research phase has focused specifically on the 10 variables (factors) that appear to differentiate success from failure, which were identified in our original study (Regan, 2015). The research sought to provide additional insight into how and why these variables might influence project success as well as to confirm that the issues identified earlier continue to persist as methodologies for EHR implementation mature. In addition, evidence was sought for other possible variables associated with success or failure. We also sought to delve more deeply into issues related to the systemic nature of healthcare innovation. Four prior studies have been identified to date that address the same questions as the current study in trying to determine what factors distinguish health IT implementations that achieve their intended goals from those that fail or fall short (Adler, 2007; Keshavjee, 2006; Jones, 2014; Lau, 2012). Three other literature review studies focused on identifying barriers and incentives for adoption and use (Holroyd-Leduc, 2011; Mair, 2012; Lluch, 2011). However, a number of research studies and other analyses bring up issues related to contextual variables that appear to have influenced project results, which point to

organizational interdependencies and the systemic nature of sustaining major organizational changes (Heisey-Grove, 2014; Hagland, M., 2014; Marchibroda, J., 2014; McCann, E., 2012; Punke, 2014; Singh, 2014). No studies have been identified that specifically use a systems framework to analyze the effectiveness of EHRs. However, the emergence in June 2012 of a new interdisciplinary journal, *Health Systems*, promotes the idea that all aspects of health and healthcare can be viewed from a systems perspective. The journal's underlying philosophy is that health and healthcare systems are characterized by complexity and interconnectedness, where "everything affects everything else." Therefore, the editors suggest, "problems in healthcare need to be viewed holistically as an integrated system of multiple components (people, organizations, technology and resources) and perspectives." (Brailsford, Harper, LeRouge, Payton, 2012, p.2)

Recent literature on innovation in healthcare also underscores the systemic nature of transformation (Christensen, 2009). In their study of disruptive innovation in healthcare, Christensen, Grossman, and Hwang (2009), focus on the interdependent nature of transformational changes. For example, in their discussion of disruptive business models, they state, "When disruptive innovators assume that relying on the existing value network is a cheaper, faster way to succeed, they invariably find that ensconcing their "piece" of the system into the old value network kills their innovation—or it co-opts and reshapes their disruptive business model so that it conforms to that system. Vice Versa never happens."

Dr. Harvey Fineberg, past president of the Institute of Medicine, stresses in a 2012 address the importance of thinking about healthcare from a systems perspective and always putting the patient at the center of the system. He cites statistics about the high error rates in U.S. medical care, and talks about the challenges of designing for safety in a complex tightly coupled system. He suggests that although we do not know all the answers to transforming U.S. healthcare, one thing we know for sure: Our U.S. medical system is perfectly aligned to get the results we are getting! He goes on to infer that if we want different results, we need to be willing to do things differently, to rethink the models through which we deliver care. He is also a strong proponent of the view that higher quality of care will lead to lower healthcare costs, and provides many concrete examples based on redesigning systems of care (Fineberg, 2012).

Insights into success versus failure can also be gained by looking at the nature of process (workflow) changes that organizations have made with health IT. Achieving the value of EHRs involves integrating across silos of care. The more successful organizations appear to have integrated process change with EHR implementation; whereas, less successful organizations often take an approach of implementing first, then addressing work process issues later. *Connected for Health*, a detailed case history of Kaiser Permanente's (KP) journey to transforming care and achieving the value of EHRs, underscores the systemic nature of transformation and stresses the centrality of strategic leadership. Editor Dr. Louise Liang, MD, served as executive consultant to Kaiser Foundation Health Plan, and from 2002 to 2009, she served as senior vice president, Quality and Clinical Systems Support, where she led the development and implementation of KP's *HealthConnect* \$4 billion-plus transformation initiative (Liang, 2010). In his assessment of this effort, Dr. Donald Berwick, president and CEO of the Institute for Health Improvement, states, "Without clear incorporation into the actual process of care and without the re-engineering of those processes, and without the changes in norms, capabilities, and culture to allow those new systems to take root, KP *HealthConnect* would become what far too many other health care organizations had already discovered in their own modernization journeys: the computerization of a defective *status quo*" (Liang, p. xvi). Although some are quick to point out the uniqueness of KP as an integrated health system, their experience is instructive, and their former CEO George Halvorson, in reflecting on lessons learned, underscores the systemic nature of change (Liang, 2010).

Based on their targeted review of existing literature on health IT implementation and use, Rippen et al. (2013) identified five major facets of an organizational framework for providing a structure to organize and capture information on the implementation and use of health IT. The authors propose a new organizational framework for health IT implementation and use with five major facets: technology, use, environment, outcomes and temporality.

A systematic review of the health information technology research sponsored by the Office of the National Coordinator for Health IT (ONC) (Jones, Rudin, Perry, Shekelle, 2014) observed that very few studies report adequate information on implementation and context of use to determine why most health IT implementations are successful while some are not. They conclude that "it is no longer sufficient to ask whether health IT creates value;

going forward, the most useful studies will help us understand **how** to realize value from health IT (Jones, 2014, p.52). They call for researchers to shift the focus **from if to how** by promoting research that empirically studies the mediating effects of contextual and implementation factors on the relationship between health IT and key healthcare outcomes. The lack of reporting about context and implementation details raises a question of whether these important factors are being ignored during implementation or if researchers are overlooking them or consider them unimportant.

Recent research viewing IT-associated organizational change through the lens of Affordance Actualization theory shows promise of providing new insight into **how** and **why** outcomes occur, rather than on **what** outcomes occur and **what** the major barriers to those outcomes are (Strong, 2014). An affordance is defined as “what is offered, provided, or furnished to someone or something by an object” (which in our case would be an EHR system) (Volkof & Strong, 2013). Thus affordances can essentially be seen as potential benefits or value of using EHR systems. The theory shifts the view of EHR implementation as a single intervention to a greater focus on the dynamic process by which outcomes are achieved—in our view a systemic perspective. Instead of examining outcomes at a single level, it examines the multi-level dynamics of “actualization” (which in our view would be achieving the potential of health IT) focusing on how the organizational change process and outcomes emerge from individual actualization processes and their immediate concrete outcomes.

In conclusion, the growing body of research on EHR implementation identifies many variables associated with the implementation of electronic health record systems, but little evidence that may explain the wide variation in results achieved.

THEORETICAL FRAMEWORK.

The theoretical framework for this study is systems theory. System theory provides a framework for examining the fit among technology, people, structure, and process and has been widely applied in examining organizational behavior across many settings, especially in the workplace. The applicability of systems theory to research in healthcare settings has been established by a number of researchers (Brailsford, 2012; Payton, 2011; Frank & Murray, 2000). The dictionary defines a system as *a set of interacting or interdependent components forming an integrated whole*. Mingers & White (2010) provide a useful summary of the way in which the systems approach is generally understood among system researchers:*

- Viewing the situation holistically, as opposed to reductionistically, as a set of diverse interacting elements within an environment.
- Recognizing that the relationships or interactions between elements **are more important** than the elements themselves in determining the behavior of the system.
- Recognizing a hierarchy of levels of systems and the consequent ideas of properties emerging at different levels, and mutual causality both within and between levels.
- Accepting especially in social systems that people will act in accordance with different purposes or rationalities.

Phase Two of our research has focused more specifically on the systemic nature of IT-based innovation and change to gain greater insight into **how** context interacts with technology in impacting results. As the focus of IT implementation shifts to optimization (achieving the value from EHRs) and moves out of the domain of an IT project to the domain of clinical transformation, we might logically expect that process and context variables would become increasingly important in achieving healthcare improvement outcomes.

METHODOLOGY

This article addresses Phase Two of a multi-phase research project. The primary method for Phase One of the study was a systematic analysis and synthesis of published research, case studies, and other health IT implementation reports and innovation projects. The search process focused on identifying multifunctional health IT interventions

* The first author is well versed in systems theory. However, an in-depth discussion is not within scope of this article primarily for space limitations. A large body of theory and practice is readily available to interested readers.

using EHRs that encompassed at least some of the functionalities required under meaningful use. Fifty studies and cases were analyzed for the first phase. The objective for Phase One was to identify a robust sampling of implementation projects. Prior research shows that “Many of the same lessons were extracted from widely different care settings” (Ludwick, 2009, p24; Lluch, 2011, p.852). Searches of several IT and healthcare databases were conducted (PubMed, Google Scholar, AHRQ, HealthAffairs). Search strategies used terms such as health IT, health information technology, health informatics, health IT implementation, EHR implementation, CPOE implementation, Meaningful Use, healthcare innovation, and similar terms.

The analysis focused on identifying people, technology, structure, and process variables associated with success or failure of health IT implementation and innovation projects. The first step was to compile a comprehensive listing of variables identified as incentives and barriers to adoption and use, including the presence or absence of factors commonly cited as best practices. The next step was to organize the different variables to eliminate redundancies due to variability in use of terminology. The refined list of variables was used to systematically study each research report or case study to analyze and catalog how the variables related to the reported results of the project. Most studies focused on only a subset of the total list of variables. Reported findings as well as the discussion, lessons learned and conclusions were used for this purpose. The final step was then to look for patterns or commonalities across the sample of reports and how they were associated with success and failure.

A similar process was used in at least three other systematic reviews we identified (Jones, 2014; Lau, 2012; Kashavjee, 2006). Overall, however, few research projects have approached evaluation of EHRs from a systemic framework. Many of these studies have focused more on user acceptance issues than on the value achieved from a healthcare outcomes perspective. Moreover, most research projects that have attempted to evaluate the effectiveness (i.e. value) of EHR implementation, have focused fairly narrowly on a specific set of factors. Findings related to context variables or other more systemic issues are often reported in relation to lessons learned rather than having been assessed as variables in the study.

Phase Two of the study has focused specifically on two strategies:

1. Analyzing the reported results of additional research projects and case studies published since 2012 to assess if more recent experience confirms, extends, or contradicts findings and conclusions of Phase One.
2. Reviewing related literature on the ten specific CSFs identified in Phase One, including health IT-related theories and models, in an attempt to gain further insight into how and why they impact the success or failure of EHR systems—and thus on the ultimate value achieved from the transition to electronic health records in terms of healthcare outcomes. Although we focused on the literature related to healthcare, this exploration took us outside of healthcare to look at achieving the value of IT in other settings as well.

The objective of Phase Two is to help ensure that we are looking at the right things and asking the right questions in subsequent, more empirical, phases of the study.

Definitions

For the purpose of this study, success is defined as targeted measurable improvements in healthcare outcomes established in advance for health IT projects. Both process and health outcomes were considered. Failure is defined as significantly falling short of targeted measurable improvements in healthcare outcomes, low buy-in among intended user population (under 60%) leading to only partial use of functionality and continuation of former (paper) practices, or reduction in project goals, or cancellation of project. This study did not make any distinctions between the terms EHR and EMR and used both terms interchangeably in selecting health IT implementations to evaluate. (Specific subsystems, such as e-prescribing and CPOE, are encompassed within our EMR/EHR definition) Studies in both hospital and multiple practice settings are included. Meaningful Use is defined in the broad sense under the intent of promoting the effective use of health IT to innovate and improve the delivery and outcomes of care. Although recognizing the specific measures used for reimbursement under the HITECH Act incentive programs, the use of the term here is much broader.

Research Questions

1. What factors have been associated in the literature with successful implementation of health information technology?
2. What factors have been associated in the literature with the failure of health information technology implementation?
3. What factors appear to be most common across all settings and projects?
4. How did contextual or implementation factors influence or mediate results of health IT implementations?
5. Are any interdependencies evident among variables?
6. Are any patterns evident in factors that differ between successful and unsuccessful implementation experiences?

FINDINGS

One of the challenges of the study analysis has been dealing with the sheer magnitude of variables associated in the literature with effectively implementing health IT in the complex healthcare environment. The major objective was to systematically analyze health IT implementation research and case studies from a multidisciplinary systems framework to determine if it is possible to identify a set of variables that are consistently associated with project success and, therefore, may be hypothesized to differentiate success from failure to achieve meaningful use of health IT.

Analysis of the selected health IT literature revealed ten factors that consistently emerged among innovative organizations reporting significant improvement in quality of care and patient outcomes. Findings from Phase Two of the study have substantially confirmed earlier findings, although some sources classify or describe them from somewhat different perspectives. Descriptions and labels for these ten factors have been refined based on the findings of our Phase Two research. Synthesizing the prior research revealed many overlaps and different perspectives on categorizing them, which suggest interdependencies among them. In addition, the continued exploration underscores the systemic nature of large-scale organizational change (i.e., innovations and transformation). Thus, it may be more accurate to think about the factors more as “themes” or “components” of creating a culture of innovation as opposed to isolated factors that could singularly make or break a health IT project.

Realizing the Value of EHRs: What Differentiates Success from Failure?

Achieving meaningful use of health IT starts at “Go Live!” That appears to be one of the prevailing themes of organizations that achieve results and realize the value of health IT. However, the EHR implementation process itself is equally important in setting the stage for success. Even organizations that paid considerable attention to workflow (i.e. process) redesign as part of implementation saw it as just the beginning of their journey to value realization. In Phase 2, we have expanded upon the ten factors originally identified with success of health IT implementation. The expanded explanation puts more emphasis on the systemic nature of factors and *how* they influence success or failure.

Process Factors:

1. Active CEO commitment (with a focus on shared vision, building buy-in, and creating a compelling case for change aligned with organizational mission). Visible leadership from the top was one of the most dominant factors associated with successful implementation of EHR. Top leadership at successful organizations seemed to have a keen sense of the importance of setting the stage for major change and how challenging it would be. They were especially adept at aligning organizational goals with technology goals and communicating the big picture of how and why the transition to electronic health records was essential for moving the organization forward in today’s changing healthcare environment. They were often very adept not only at creating a sense of urgency for their own organizations to change, but tying it into the need for change on the national level as well in order to achieve the goals of improved care, greater access and lower cost. They effectively tied change initiatives to achievement of clinical improvement goals and why it was in everyone’s self-interest to support the initiative, thus helping to build buy-in. Effective CEO’s consistently reinforced their message and persevered when the going got rough. Importantly, they also seemed to understand the implications of changes for other aspects of

hospital or practice management and acted accordingly, which proved important to eliminating barriers to change.

2. Patient-centered care and patient engagement. The most successful organizations appear to be leaders in moving to more patient-centered care (also referred to as process-centered care) models. It often encompasses the notion of putting patient safety first as well. Ultimately the success of patient engagement is determined by the quality of the interaction between patients and clinicians. It takes advantage of new tools, such as Web patient portals, shared patient records, e-consultation systems and online data access for patients, and increasingly mobile apps, home monitoring devices, and more. The distinguishing factor appears to be a focus on two-way interaction rather than information push. Some innovators see it as a major paradigm shift from today's task-focused, provider centric institutions, which is leading to emergence of new models for care, usually based on a more integrated team approach to care.
3. Quality focus with clinical benchmarks for monitoring success. The most successful organizations had clearly created a culture of quality that started at the top. Policies and benchmarks were aligned with their goals, with a top priority on clinical, health outcome goals, and also process improvement goals. It was often expressed in terms of putting patient safety first in the mission of the organization. Goals were collaboratively developed, explicitly defined, and widely shared. Goals were tracked regularly and transparently with clear benchmarks for success.
4. Workflow (process) integration. The most successful organizations clearly viewed workflow redesign as an opportunity to improve continuity of patient care, gain efficiencies, and improve care outcomes. Indeed workflow redesign was seen as key to achieving value from health IT systems for patients, providers, and the organization. Leadership for successful workflow redesign resided with physicians, nurses, and other providers with high involvement and buy-in of clinical staff. Projects were well planned, orchestrated, and resourced. Workflow redesign was an ongoing process that started with Go Live. It was also iterative; as clinicians gained experience with new systems, they gained new insight into opportunities for improving care delivery. As clinicians gained experience, innovations tended to become more integrated across former silos of care with more aggressive patient outcome goals.
5. Strong leadership of clinical professionals (physicians and nurses). Highly successful healthcare systems inevitably had strong, visible physician leaders who had a clear vision for the potential for electronic health information and exchange to transform care in positive ways. They were effective in working with their peers and enlisting their buy-in to change by helping them see the benefits longer term for themselves, their patients, and the institution. Strong nursing leadership also appeared to be vital. Nurses clearly had a perspective of the patient care workflow different, and in many ways more detailed, than physicians. Working relationships between physicians and nurses were critical to redesigning workflows. Role changes were often indicated, especially with a shift to more team-based care. Clinicians could be both strong enablers as well as strong barriers to change.
6. Engagement, Training, On-going Support. Clinician engagement on all levels was critical to success. Understanding of what was required of clinicians and why it was important could NOT be assumed. Training was cited in every case as critical to success. However the quality of the training and support was equally important. Training both initial and ongoing and incremental was critical for smooth transition to a paperless patient care system. Hands-on training immediately prior to Go Live as well as on-going training was both critical. Training needs differed among clinicians and at different stages of the process. An especially distinguishing feature among the success stories was that training was also viewed as a means of engaging staff members in implementation. Training provided one to one, just in time, 24/7 minimizes frustration, provides opportunities to educate about appropriate use, identifies corrections, and allows further improvements to minimize potential medication errors (First Consulting Group, 2006). Training was also viewed as an opportunity to reinforce best practices.

Contextual Factors:

7. Supportive organizational climate for innovation. Successful organizations were able to create a climate or culture that was supportive of change and encouraged clinicians to try new ideas while realizing that not all ideas would prove to be effective. Recognizing that there are both technical and social aspects to technology implementation, successful organizations appear to be more sensitive to the opportunities from the viewpoint that the technology and the organization transform each other during the process. Even with a well-thought out plan, the process can actually take on a life of its own, and a system for flexibility is essential. Feedback, dialogue, interventions, and activities all play important roles; innovation is iterative.

A culture of innovation appeared to be strongest when it cascaded from the top throughout the organization and clearly aligned with the mission of the institution.

8. Collaborative culture (teamness).

Evidence suggests that participation and engagement are vital for the success of new technologies. Successful organizations tend to create a cooperative dynamic where end users solve technical problems, write templates, and teach each other about software features. Teamwork is a major pillar. Collaboration is a clear expectation. The value that seems to bring the various medical professional groups together for integration is a broad consensus about the importance of effective and efficient care. A collaborative approach is viewed as critical during design, development, implementation, and post-implementation phases (optimization). Most often the staff, not the physician, has the best knowledge of existing and optimized processes. Different members of the workforce bring different perspectives and skills; interdisciplinary approaches generally are viewed as most effective.

9. Systems perspective on change (holistic view). Success of EMR implementation and use depends on integrating the system into often complex organizational settings. "The ultimate value achievable from an investment in health IT is directly related to the breadth of integration it provides across all parts of the healthcare delivery system (Ajami& Bagheri-Tadi, 2013). Workflow redesign is critical because of the need for realignment to realize the value of technology investments and improve quality. Efforts generally affect patient--clinician relationships job roles, incentives, as well as workflows and clinical practice routines. It is more like building a new ship rather than just moving the deck chairs around. A systems perspective helps clarify interdependencies and points of interaction between what are often relative silos of operation. These are the points in the care system where patients tend to get "lost" or errors occur as hand-offs are made. The most innovative organizations focused on improving coordination of care, which generally means better communication and coordination across different functions and care units and often present the best opportunities for streamlining processes, improving coordination of care, and reducing medical errors.

Technology Factors:

10. Technology reliability, responsiveness and interoperability. Technology usability, reliability, responsiveness and interoperability repeatedly came up in the literature as key factors (Fellmeth, 2014). Availability of local technical support was seen as critical. EHR technical design, performance and support reportedly affected its usage and user satisfaction. Other concerns related to reliability and security. The presentation of information in the EHR was identified as a major issue, especially when it did not map to workflow. This issue underscores the importance of the EHR (or other health IT) selection processes since there are many competing systems with varied interfaces and functionality. It was not possible to assess the extent to which lack of fit of EHR technology to practice needs might be attributed to general deficiencies in all EHR systems or whether it might be attributed to a failure to make a good choice of system for practice needs. Inadequate training is also sometimes misdiagnosed as technical problems when users are unaware or incorrectly use functionality. A lack of interoperability and information exchange infrastructure and associated costs are the most common barriers to information sharing among clinicians.

Table 3 shows the frequencies for each of the ten critical success factors for meaningful use. Not all articles, case studies, or reports necessarily identified all ten success factors. Some study reports were more comprehensive in reporting on the full scope of the implementation process whereas others were more focused on less comprehensive objectives. These factors came up consistently across different projects, but the terminology and frame of reference varied. For example, for the factor "Active CEO Commitment," here are some examples of how the importance and impact of the factor was reported in different studies. (Note these are brief statements; in most cases the discussion was more detailed.)

- Support of the policy making level is required for widespread health IT adoption beyond pilot stages (Lluch, 2011).
- Governance refers to senior management's activities or substantive personal interventions in the management of the EMR implementation. It is concerned with mission, vision and top management's behaviors related to pre-implementation, implementation, and post implementation of the EMR (Kashavjee, 2006).
- Successful implementations are supported by executives (Ludwick, 2008).

- Shared vision for care delivery starts with the end in mind (ONC, 2014).
- The work of relating and engaging with users is central to the successful implementation of any new technology and starts at the top levels (Mair, 2012).
- “Sense-making” is an important aspect of implementation. Sense making deals with having a shared view of its purpose, understanding how it will affect them personally, and grasp its potential benefits (Mair, 2012).
- Vision, support, and involvement starts with upper management (Metzger, 2003).
- CEO must be on board (Metzger, 2003)
- Mindset that CPOE (or any change) is the right thing to do, not focused primarily on ROI (Metzger, 2003).
- In every hospital, much effort was expended to convince physicians that CPOE was a necessary investment in patient safety and quality (First Consulting Group, 2006).
- Coordination of business and IS planning is successful only if mandated by top management (Lederer, 1989).
- Leadership recognizes that there will be bumps in the road and will be unwavering. Commitment equals resources, multi-year effort, not expecting immediate results (Metzger & Fortin, 2003).

Table 3. CSF For Meaningful Use: What Differentiates Success from Failure?

Critical Success Factors	Frequency of Citations
Active CEO commitment (with a focus on mission, vision, building buy-in, and creating a compelling need for change)	37
Patient-centered care and patient engagement	24
Quality focus with clinical benchmarks	30
Workflow integration	33
Strong leadership of clinical professionals (physicians and nurses)	44
Engagement, training, ongoing support	32
Supportive organizational climate for innovation	18
Culture of collaboration	26
Systems perspective	38
Technology reliability, responsiveness, interoperability	28

DISCUSSION

This section addresses the six research questions addressed by the study. Table 1 and 2 underscored the complex process of implementing new health IT systems. With more than 100 factors identified in the research that are believed to influence implementation results, the two frameworks shown in Tables 1 and 2 help to clarify the many requirements for EHR implementation. However, not only have these frameworks failed to substantially improve results, neither do frameworks such as these answer the question of what differentiates success from failure for those organizations that follow them. Our study essentially asks: Out of everything that must be addressed for a successful health IT implementation, what are the critical success factors to ensure the organization achieves their clinical improvement targets? What do CEOs need to focus on to ensure they get it right? The research has identified 10 themes (CSFs) that consistently emerged from innovators that reported significant improvements in care goals and patient outcomes. The findings became the basis for classifying and describing ten critical success factors, only one of which relates directly to technology. The others are contextual and process factors. Moreover, the evidence points to multiple interdependencies among these variables, none of which have yet been empirically verified. It is not that all the myriad of factors are not important. It is more a matter of creating focus for top managers and project leaders to steer the ship.

A prevailing theme among successful organizations is a view of achieving value from health IT as a shared journey, aligning initiatives with organizational goals for clinical improvement and the institutional mission. Successful organizations tend to see challenges as opportunities rather than problems. The organizations developed a culture that encouraged innovation, supported change, and viewed failure as part of the learning process.

In addition, studying the issues from a systems framework provides insight into the complexity of clinical innovation. It shifts the perspective from viewing EHR implementation as a single event to looking at the dynamics of achieving value of EHRs as an iterative process that involves the interaction of technology, people, and process at both individual and organizational levels.

Research Limitations

Our search was limited to English language articles and cases published since 2000 (with a few exceptions). Emphasis was placed on the most recent studies because of the rapid advancement of EMR implementation in the past few years and to gain the viewpoint of medical practices that had some history of use. A structured analysis process was used to synthesize prior research. However, due to the nature of qualitative studies, it is difficult to entirely rule out biases in the analysis and interpretation of findings, and therefore may have limited generalizability. Although the research included international studies, the predominant focus was on the United States health care system, and cultural differences that might influence study findings are not specifically taken into consideration.

In addition, although not specifically documented in the study, the first author's many years of experience in implementing IT change in a variety of settings as well as knowledge of case studies, presentations at conferences, stories of innovation award winners by organizations such as HIMSS and Health Informatics Magazine, workshops, etc. also influenced and reinforced the conclusions from trends specifically identified through the structured analysis conducted in the study. Thus although as a researcher one might claim impartiality, it is hard to rule out bias in a qualitative study.

IMPLICATIONS FOR PRACTICE AND FUTURE RESEARCH

The research has direct implications for clinical practice. It addresses important questions that should be of interest to every healthcare provider engaged in IT based initiatives to improve the delivery of care, which usually require a huge investment of resources. Given the large number of projects that fail to fully achieve the intended benefits from EHR implementation, identifying factors that could help improve the success rate of initiatives would have significant and widespread benefit.

The findings of this study suggest that technology is only one of ten (or possibly more) factors that interact systemically to affect the meaningful use of health information technology. Thus, when measuring or researching the impact of health information technology, it is critical to differentiate between issues, problems and results that truly can be attributed to technology versus those related to contextual issues. Putting the technology in place, training people to use it, and converting paper records to electronic is only a necessary but not sufficient step toward achieving the value of EHR systems. It is also probably the easiest part. It sets the stage and provides new tools. Gaining the insight into *how and why* EHR systems can be used to change the way care is delivered to increase quality, improve access, and reduce cost is a dynamic, iterative process that has implications for every aspect of healthcare operations, and thus can best be viewed systemically. Making the process and organizational changes takes hard work, commitment at all levels starting at the top, engaging the entire organization, and focusing on what is best for patients.

Beyond the immediate institutional impact, projects that fail to achieve anticipated results can have consequences for progress toward transforming healthcare on a national level. Failures that are misinterpreted as failures of technology rather than failures of implementation methods or other factors, especially when reported in the health IT literature, can be counterproductive and can influence decisions of policy makers or industry leaders.

For the authors, the study is intended as a foundation for further research. It is hoped that other researchers will also find the results useful as a foundation for future research to inform understanding of *how* health IT can create value in healthcare delivery and outcomes. It is hoped that the findings will provide focus for more empirical research and

comparative effectiveness studies of contextual and organizational factors critical to the success of health IT transformation projects. Analyzing individual factors is insufficient to fully understand the dynamic relationships that affect the ability to effectively use health IT to transform care. A holistic systems approach can help deepen our understanding in ways that can help improve the success rate in using health IT to innovate and improve healthcare practice and patient outcomes.

REFERENCES

- Aarts, J., & Peel, V. (1999). *Using a descriptive model of change when implementing large scale clinical information systems to identify priorities for further research*. [Int J Med Inform. 1999] - PubMed - NCBI. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/10659933>
- Aguirre, D. & Alpern, M. (2014). 10 Principles of Leading Change Management, *Strategy+Business*, Issue 75.
- Adler, K. G. (2007). How to Successfully Navigate Your EHR Implementation - Family Practice Management. *Family Practice Management*, 14(2), 33-39. Retrieved from <http://www.aafp.org/fpm/2007/0200/p33.html>
- Ajami, S., & Bagheri-Tadi, T. (2013). Barriers for Adopting Electronic Health Records (EHRs) by Physicians. *ACTA INFORM MED*, 21(2), 129-134. doi:0.5455/aim.2013.21.129-134.
- Bipartisan Policy Center Health Information Technology Initiative, (2012). *Accelerating Electronic information sharing to improve Quality and reduce costs in health care*. Retrieved from http://bipartisanpolicy.org/sites/default/files/BPC%20Accelerating%20Health%20Information%20Exchange_format.pdf.
- Brailsford, S., Harper P., LeRouge, C, Payton, F.C. (2012). Editorial, *Health Systems* (1:1) pp 1-6.
- Byers, J. (2012). More IT Systems Call For More IT Talent. *CMIO Magazine*.
- California HealthCare Foundation (2012). *E-Prescribing in California: Why Aren't We There Yet?* Oakland, CA: California HealthCare Foundation.
- Center for Improving Medication Management. eHealth Initiative (2008). *Electronic prescribing: Becoming mainstream practice: a collaborative report*. Washington, D.C: eHealth Initiative.
- Christensen, C. M., Grossman, J. H., & Hwang, J. (2009). The Innovator's Prescription. *A Disruptive Solution for Healthcare*. New York: McGraw-Hill.
- Coplan, S. & Masuda, D. (2013). When Worlds Collide: The Cultural Side of Health IT Failure. *JHIM*, 27(1) 15-17.
- Cresswell, K. and Sheikh, A. (2013). Organizational issues in the implementation and adoption of health information technology innovations: An interpretive review. *International Journal of Medical Informatics*. 83(2013) e73-e86.
- Crosson J. C., Isaacson N, Lancaster D, et al. (2007). Variation in electronic prescribing implementation among twelve ambulatory practices. *J Gen Intern Med* 23(4):364-371.
- Crosson, J. C., Etz, R. S., Wu, S., Straus, S. G., Eisenman, D., & Bell, D. S. (2011). Meaningful Use of Electronic Prescribing in 5 Exemplar Primary Care Practices. *The Annals of Family Medicine*, 9(5), 392-397. doi:10.1370/afm.1261.
- Crosson, J. C., Stroebel, C., Scott, J. G., Stello, B., & Crabtree, B. F. (2005). Implementing an electronic medical record in a family medicine practice: communication, decision making, and conflict. *Annals of family medicine*, 3(4), 307-311. doi:10.1370/afm.326.

- Decker, S. L., Jamoom, E. W., & Sisk, J. E. (2012). Physicians In Nonprimary Care And Small Practices And Those Age 55 And Older Lag In Adopting Electronic Health Record Systems. *Health Affairs*, 31(5), 1108–1114. doi:10.1377/hlthaff.2011.1121.
- Devine, E. B., Hansen, R. N., Wilson-Norton, J. L., Lawless, N. M., Fisk, A. W., Blough, D. K., Sullivan, S. D. (2010). The impact of computerized provider order entry on medication errors in a multispecialty group practice. *Journal of the American Medical Informatics Association: JAMIA*, 17(1), 78–84. doi:10.1197/jamia.M3285.
- Dixon, B. E., & Samarth, A. (2009). *Innovations in Using Health IT for chronic Disease Management* (09-0029-EF). Retrieved from AHRQ National Resource Center for Health Information Technology website: http://healthit.ahrq.gov/sites/default/files/docs/page/09-0029-EF_cdm_1.pdf
- Dixon, B. E., & Zafar, A. (2009). *Inpatient Computerized Provider Order Entry (CPOE)* (09-0031-EF). Retrieved from AHRQ National Resource Center for Health Information Technology website: <http://healthit.ahrq.gov/ahrq-funded-projects/emerging-lessons/computerized-provider-order-entry-inpatient/inpatient-computerized-provider-order-entry-cpoe>
- Falkenburg, N. (2004). *Insights by Community Clinics on Information Technology Adoption*. Retrieved from Community Clinics Initiative website.
- Fineberg, H. Safe and High Quality Health Care, address delivered at Beckman Center July 17, (2012), published July 23, 2012. <http://www.youtube.com/watch?v=hqIXQIBPPEc>
- First Consulting Group (2006). *CPOE lessons learned in community hospitals*. Retrieved from <http://mehi.masstech.org/sites/mehi/files/documents/CommunityHospitals2006.pdf>
- Frank, J. and Murray, C. (2000). A framework for assessing the performance of health systems. World Health Organization, *Bulletin of the World Health Organization*, 78(6), 717-731.
- Furukawa, M., & Gabriel, M. (2012), September 4). *Meaningful use of Health IT improves quality safety efficiency Outcomes*. Retrieved January 9, 2014, from <http://www.healthit.gov/buzz-blog/electronic-health-and-medical-records/meaningful-use-healthit-improves-quality-safety-efficiency-outcomes/>
- Gans, D., Kralewski, J., Hammons, T., & Dowd, B. (2005). Medical groups' adoption of electronic health records and information systems. *Health Affairs*, 24(5), 1323-1333. doi:10.1377/hlthaff.24.5.1323
- Garrido, T., Raymond, B., Jamieson, L., Liang, L., & Wiesenthal, A. (2004). Making the business case for hospital information systems--a Kaiser Permanente investment decision. *Journal of Health Care Finance*, 31(2), 16–25.
- Goroll, A. H., Simon, S. R., Tripathi, M., Ascenzo, C., & Bates, D. W. (2009). Community-wide implementation of health information technology: the Massachusetts eHealth Collaborative experience. *Journal of the American Medical Informatics Association: JAMIA*, (16:1) pp 132–139. doi:10.1197/jamia.M2899
- Hackl, W., Hoerbst, A., & Ammenwerth, E. (2011). EHR Acceptance among Physicians in Private Practice in Austria: A Qualitative Study. *Methods Inf Med*, 50, 53-61. doi:10.3414/ME10-02-0020
- Hagland, M. (2014). Improving patient safety and outcomes in critical-results reporting. *Healthcare informatics: the business magazine for information and communication systems*, 31(1), 51.
- Huerta, T. R., Silvera, G. A., Pettit, L., & Ford, E. W. EMR (2012). Implementation Speed.

- Heisey-Grove, D., Danehy, L. N., Consolazio, M., Lynch, K., & Mostashari, F. (2014). A national study of challenges to electronic health record adoption and meaningful use. *Medical care*, 52(2), 144-148.
- Hing, E., & Hsiao, C. (2010). *National Health Statistics Reports* (23). Retrieved from Centers for Disease Control and Prevention website: <http://www.cdc.gov/nchs/data/nhsr/nhsr023.pdf>
- HIMSS Davies Committee (2015), Hilo MedicalCenter—ROI Core Case Study. Retrieved 10/9/15 from <http://www.himss.org/ResourceLibrary/ContentTabsDetail.aspx?ItemNumber=44750>.
- H.I.T. or Miss: lessons learned from health information technology implementation*. (2010). Chicago: Bethesda, MD: AHIMA Press; AMIA.
- Holroyd Leduc, J. M., Lorenzetti, D., Straus, S. E., & Sykes, L. (2011). The impact of the electronic medical record on structure, process, and outcomes within primary care: a systematic review of the evidence. *Journal of the American Medical Informatics Association* 18(6):732-7. doi: 10.1136/amiajnl-2010-000019
- Hooks, J. M., Pearlstein, J., Samarth, A., & Cusack, C. (2008). *Using Barcode Medication Administration to Improve Quality and Safety* (09-0023-EF). Retrieved from Agency for Healthcare Research and Quality website: http://healthit.ahrq.gov/sites/default/files/docs/page/09-0023-EF_bcma_0.pdf
- Institute for Health Technology Transformation, (2011). *Top Ten Things You Need to Know About Engaging Patients*. Retrieved from Institute for Health Technology Transformation website: <http://ihealthtran.com/pdf/iHT2%20Patient%20Engagement%20Report%20-%202011.pdf>
- Jones SS, Rudin RS, Perry T, Shekelle PG. (2014). "Health Information Technology: An Updated Systematic Review with a Focus on Meaningful Use," *Ann Intern Med* 2014;160:48-54
- Keshavjee, K. K., Bosomworth, J., Copen, J., Lai, J., Kucukyazici, B., Lilani, R., & Holbrook, A. M. (2006). Best practices in EMR implementation: a systematic review. *AMIA ... Annual Symposium proceedings / AMIA Symposium*. AMIA Symposium, 982.
- Klinger, S. L., & White, S. (2010). *Lessons from a Health Information Technology Demonstration in New York Nursing Homes*. Retrieved from The Commonwealth Fund website: <http://www.commonwealthfund.org/Publications/Case-Studies/2010/Apr/Lessons-from-a-Health-Information-Technology-Demonstration-in-New-York-Nursing-Homes.aspx#citation>
- Khoja, A. (2013). Improving EMR Adoption: Key Recommendations for IT Leadership, *JHIM* 27(1) 53-61.
- Lau, F., Price, M., Boyd, J., Partridge, C., Bell, H., & Raworth, R. (2012). Impact of electronic medical record on physician practice in office settings: a systematic review. *BMC Medical Informatics and Decision Making*, 12(10). doi:10.1186/1472-6947-12-10
- Lederer, A. L., & Mendalow, A. L. (1989). Coordination of information systems plans with business plans. *Journal of Management Information Systems*, 6(2), 5-19.
- Leventhal, R. (2015). Survey: CHIME Members Prioritize EHR Optimization. *Healthcare Informatics*. September 3, 2015. Source [URL:http://www.healthcare-informatics.com/news-item/survey-chime-members-prioritize-ehr-optimization](http://www.healthcare-informatics.com/news-item/survey-chime-members-prioritize-ehr-optimization).
- Leviss, J., Editor, 2010. *H.I.T. or Miss: Lessons learned from health information technology implementations*. AHIMA American Medical Informatics Association.
- Liang, Louise L., Editor, (2010). *Connected for Health: Using Electronic Health Records to Transform Care Delivery*. San Francisco, Jossey Bass, and imprint of John Wiley and Sons 272 pgs. ISBN 0470639377, 9780470639375.

- Lluch, M. 2011. Healthcare professionals' organizational barriers to health information technologies—a literature review. *Elsevier Ireland*. doi:10.1016/j.ijmedinf.2011.09.005
- Ludwick, D. A., & Doucette, J. (2008). Adopting electronic medical records in primary care: Lessons learned from health information systems implementation experience in seven countries. *Elsevier Ireland*, 22-31. doi:10.1016/j.ijmedinf.2008.06.005
- Lukas , C. V., Holmes, S. K., Cohen, A. B., Joseph, R., Cramer, I. E., Shwartz, M., & Charns, M. P. (2007). Transformational change in health care systems: An organizational model. *Health Care Management Review*, 32(4), 309-320. doi:10.1097/01.HMR.0000296785.29718.5d
- Mair, F. S. (2012). Factors that promote or inhibit the implementation of e-health systems: an explanatory systematic review. *Bull World Health Organization*, 1(90), 357-64. doi:10.2471/BLT.11.099424
- Marchibroda, J. (2014). Health Policy Brief: Interoperability. *Health Affair*.
- Maxson, E. R., Jain, S. H., McKethan, A. N., Brammer, C., Buntin, M. B., Cronin, K., ... Blumenthal, D. (2010). Beacon communities aim to use health information technology to transform the delivery of care. *Health affairs (Project Hope)*, 29(9), 1671–1677. doi:10.1377/hlthaff.2010.0577
- McCann, E. (2012). Success story: Iowa critical access hospital implements EHRs, HealthcareITNews www.healthcareitnews.com/print/56511 posted 9/30/2012.
- McKethan, A., Brammer, C., Fatemi, P., Kim, M., Kirtane, J., Kunzman, Rao, S., Jain S.H (2011). An Early Status Report On The Beacon Communities' Plans For Transformation Via Health Information Technology. *Health Affairs*, 30, 782-788. doi:10.1377/hlthaff.2011.0166
- Metzger, J., & Fortin, J. (2003). Computerized Physician Order Entry In Community Hospitals: Lessons from the Field. *The Quality Initiative*. Retrieved from http://www.leapfroggroup.org/media/file/Leapfrog-CPOE_Comm_Hosp.pdf
- Pare, G., Sicotte, C., Poba-Nzaou, P., and Balouzakis, G. (2011). Clinicians' perceptions of organizational readiness for change in the context of clinical information system projects: insights from two cross-sectional surveys. *Implementation Science*, 6(15). doi:10.1186/1748-5908-6-15
- Payton, F. C., Paré, G., Rouge, C. M., & Reddy, M. (2011). Health Care IT: Process, People, Patients and Interdisciplinary Considerations. *Journal of The AIS* 12(2/3)
- Pelayo, S., & Beuscart-Zephir, M.C. (2010). Organizational considerations for the implementation of a computerized physician order entry. *Studies in Health Technology and Informatics*, 157, 112–117.
- Poon, M.D., M.P.H., E. G., Blumenthal, M.D., M.P.P., D., Jaggi , T., Honour, M.P.H., M. M., Bates, M.D., M.Sc., D. W., & Kaushal, M.D., M.P.H., R. (2004). Overcoming barriers to adopting and implementing computerized physician order entry systems in U.S. hospitals. *Health Affairs*, 23(4), 184-90
- Population Health Management*. (2012). Retrieved from Institute for Health Technology Transformation website: <http://ihealthtran.com/pdf/PHMReport.pdf>
- Punke, H. (2014). 3 things the most innovative health systems do, *Becker Hospital Review*, Sept.19, 2014.
- Regan, E. & Wang, J. (2015). Meaningful Use of IT to Transform Healthcare: What Differentiates Success from Failure? *Journal of Health Information Management (JHIM)* 29(1), 52-61. http://www.jhimdigital.org/jhim/winter_2015?pg=52#pg52

- Reich, B. H., and Benbasat, I. (2000). Factors that influence the social dimension of alignment between business and information technology objectives. *MIS Quarterly*, 24(1), 81-113. Retrieved from <http://www.clinical-innovation.com/topics/technology-management/more-it-systems-call-more-it-talent>
- Rippen, H. E., Pan, E. C., Russell, C., Byrne, C. M., & Swift, E. K. (2012). Organizational framework for health information technology, *International Journal of Medical Informatics*, 82(4), e1-e13.
- Rogers, E. M. (2003) *Diffusion of Innovations*, 5th Edition. Simon and Schuster.
- Singh, R., Mathiassen, L., Switzer, J. A., & Adams, R. J. (2014). Assimilation of Web-based Urgent Stroke Evaluation: A Qualitative Study of Two Networks. *JMIR Med Inform* 2(1):e6 URL: <http://medinform.jmir.org/2014/1/e6/> doi:10.2196/medinform.3028.
- Scott, S. G., & Bruce, R. A. (1994). Determinants of innovative behavior a path model of individual innovation in the workplace. *Academy of Management Journal*, 37(3), 580-607.
- Strong, D. M., Johnson, S. A., Tulu, B., Trudel, J., Volkoff, O., Pelletier, L. R., Bar-On, I., Garber, L. (2014). A Theory of Organization-EHR Affordance Actualization, *Journal of the Association for Information Systems* (JAIS) 15(2) 53-85.
- Thompson, D., & Adams, K. (2004). *Tackling Organizational Change in Health Information Management: Two Canadian Experiences*. Retrieved from http://library.ahima.org/xpedio/groups/public/documents/ahima/bok3_005555.hcsp?dDocName=bok3_005555
- Trist, E. L. 1981. *The evolution of socio-technical systems: a conceptual framework and an action research program*. Toronto: Ontario Ministry of Labour, Ontario Quality of Working Life Centre.
- Volkoff, O. & Strong, D. M. (2013). Critical Realism and Affordances: Theorizing IT-Associated Organizational Change Processes, *MIS Quarterly*, 37(3) 819-834.
- Wager, K. A., & White, A. W. (2000). Impact of an Electronic Medical Record System on Community-Based Primary Care Practices. *JABFP*, 13(5), 338-348.
- Zaroukian, M. H., & Sierra, A. (2006). Benefiting from ambulatory EHR implementation: solidarity, six sigma, and willingness to strive. *Journal of healthcare information management: JHIM*, 20(1), 53-60.